Traffic Safety Monitoring System

Shivanagendar Mandala, Srinivas Reddy Masireddy, Kiran Banoth, Pradeep Chandra Mandru and Rasna Patel

March 27, 2024

TRAFFIC SAFETY MONITORING SYSTEM

Mandala Shiva Nagendra
CSE Department Parul University
Vadodara, India
mandhalakushi369@gmail.com

Masireddy Srinivas Reddy
CSE Department Parul University
Vadodara, India
srinivasreddymasireddy2701@gmail.com

Banoth Kiran
CSE Department Parul University
Vadodara, India
luckykiran074@gmail.com

Mandru Pradeep Chandra
CSE Department Parul University
Vadodara, India
Pc429826@gmail.com

Rasna Patel
Assistant Professor
CSE Department Parul University
Vadodara, India
rasna.patel22289@paruluniversity.ac.in

Abstract—**The integration of advanced technologies in traffic enforcement represents a paradigm shift in urban safety management. By harnessing the power of Convolutional Neural Networks (CNNs) and Easy OCR, this project pioneers a holistic approach to address the complex issue of traffic violations. The CNN's ability to discern number plates, coupled with Easy OCR's proficiency in extracting alphanumeric data, forms a synergistic alliance that promises unparalleled accuracy in offender identification. Furthermore, this research undertakes an in-depth analysis of the socio-economic impact of traffic violations. The resulting data illuminates the potential cost savings and lives preserved through the reduction of accidents and injuries. By curbing reckless driving behaviors, the project aligns with broader societal goals of reducing healthcare expenses and lost productivity due to traffic-related incidents. Moreover, the study takes into consideration the scalability and adaptability of this technology. With the rapid urbanization and motorization witnessed in India, a system that can efficiently adapt to varying traffic densities and infrastructural complexities is paramount. The robustness of the proposed solution ensures its applicability not only in bustling metropolitan areas but also in emerging urban centers, thereby democratizing access to advanced traffic safety measures. Additionally, this project underscores the significance of international collaboration in the realm of traffic safety. By sharing insights and methodologies, the global community can collectively work towards harmonizing traffic regulations and enforcement strategies. This collaborative approach not only fosters mutual learning but also bolsters the collective ability to tackle traffic safety challenges on a global scale. In summary, this research initiative stands at the forefront of leveraging technology for safer roadways. Through the fusion of CNN and EasyOCR, it offers a holistic and adaptable solution to the intricate problem of traffic violations in India. The potential ramifications extend far beyond the immediate benefits to encompass a broader vision of international cooperation and urban safety advancement.**

I. INTRODUCTION

In the midst of India's bustling streets and dynamic traffic systems, a symphony of motion and chaos intertwines. With millions of vehicles weaving through the urban tapestry each day, the tapestry of traffic safety is at the forefront of our collective consciousness. The surge in vehicular presence, coupled with the kaleidoscope of driving behaviors, has given rise to a mosaic of traffic infractions. This necessitates a call for ingenious solutions that not only bolster safety but also act as vigilant sentinels of regulation enforcement. The non-compliance with traffic norms unfurls a dangerous tableau, a menacing threat that casts a long shadow over the safety of both those behind the wheel and the pedestrians navigating the margins. This escalating disregard has sown the seeds of a grim harvest: a surge in accidents, a tapestry woven with threads of injuries, and the mournful toll of fatalities. Beyond the visceral pain and suffering, there lies an undercurrent of economic upheaval, with its tendrils snaking into property damage, the mounting ledger of medical expenses, and the erosion of productivity. To navigate these treacherous waters, a clarion call for action echoes through the avenues and boulevards. Traffic violations, those brash acts of rebellion against the established order, range from the feverish heartbeat of overspeeding to the audacious choreography of reckless driving, all the way to the insubordination against the sentinel traffic signals. These transgressions are not merely isolated acts, but cascading ripples that reverberate through the flow of traffic, engendering logjams and delays that pulse through the city's arteries. In this crucible of chaos and order, the exigency for swift intervention is unequivocal. It is imperative that we wield the gavel of authority, but also the brush of education and awareness. Through a multi-faceted approach that combines rigorous enforcement with public engagement and education, we can hope to gradually untangle this intricate web of peril.

II. LITERATURE REVIEW

Traffic Safety Monitoring System represents a groundbreaking approach to addressing the pressing issue of traffic violations in India. By incorporating cutting-edge technologies such as Convolutional Neural Networks (CNN) for number plate detection and EasyOCR for efficient information extraction, we're poised to revolutionize the entire paradigm of traffic management. Artificial Intelligence (AI) stands as the cornerstone of this transformative system.

1) Computer Vision and Deep Learning in Traffic Safety

Monitoring:

Object detection is a fundamental task in computer vision for identifying and localizing objects within an image or video frame.

In traffic scenes, object detection algorithms are used to identify various entities such as vehicles, pedestrians, cyclists, and traffic signs/signals.

2) EasyOCR :

EasyOCR is a Python package for optical character recognition (OCR) that provides a simple and efficient way to extract text from images,

3) Convolutional Neural Networks (CNNs):

Convolutional Neural Networks (CNNs) are a class of deep neural networks specifically designed for processing visual data such as images.

4)InceptionResNetV2 Architecture:

InceptionResNetV2 is a state-of-the-art deep neural network architecture that combines the concepts of both the Inception architecture and residual connections from ResNet. Traffic Sign and Signal Recognition:

Traffic signs and signals convey critical information to drivers and pedestrians, ensuring safe and efficient navigation on roads.

Computer vision systems analyze images to detect and recognize various traffic signs and signals, including speed limits, stop signs, traffic lights, and pedestrian crossings.

Convolutional neural networks (CNNs) and deep learning-based approaches have shown remarkable performance in recognizing traffic signs and signals with high accuracy and efficiency.

III. METHODOLOGY

This The number plate detection system implemented in this project represents a sophisticated fusion of Convolutional Neural Networks (CNNs) and EasyOCR, a powerful optical character recognition tool. At its core, the CNN model draws its foundation from the formidable InceptionResNetV2 architecture, a pre-trained deep learning model renowned for its prowess in image recognition tasks.

The journey commences with a meticulous setup: InceptionResNetV2 takes center stage

1**. Data Collection:** The journey embarks with a meticulous curation of a diverse and comprehensive dataset. This corpus encompasses a wide array of license plate images, capturing a spectrum of real-world scenarios

2 . **Data Processing**: With raw data in hand, a series of intricate transformations unfurl. Images undergo resizing, normalization, and augmentation, imbuing them with uniformity and resilience to noise. This preparatory phase lays the foundation for the model's ability to extract pertinent features.

3. Model Design: The architectural blueprint is meticulously crafted, amalgamating the InceptionResNetV2 base with bespoke adaptations. Top layers are excised, and a specialized Output layer is birthed, poised to predict number plate coordinates. Careful considerations are made in layer configurations, activation functions, and dropout rates.

4. Training and Fine-tuning: The model steps into the crucible of training, where epoch after epoch, it refines its ability to discern intricate patterns. The last ten layers, held sacrosanct, ensure that prior knowledge isn't lost, while the rest adapt to the nuances of license plate detection.

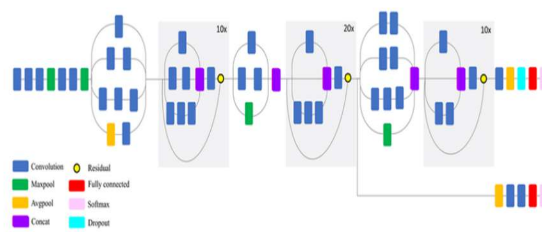
5. Validation and Testing: A rigorous assessment ensues, where a dedicated validation set scrutinizes the model's performance. Once validated, the model faces a battery of test cases, assessing its mettle in real-world scenarios.

6. Integration with EasyOCR: The fruits of CNN labor are seamlessly integrated with EasyOCR, a potent OCR tool. This fusion empowers the system to not only locate number plates but also decipher their alphanumeric contents.

7. Deployment and Evaluation: The trained model, now battle-hardened, is deployed in real time or batch processing environments. Its efficacy is quantified through metrics like mean squared error, ensuring its precision in predicting number plate coordinates.

The output from the InceptionResNetV2 undergoes a transformation, undergoing flattening before traversing a crucible of dropout layers with a judicious rate of 0.5. This is a crucial step in curbing the specter of overfitting, allowing the model to generalize its learning from the training data to new, unseen examples.

The architecture then unfurls further, revealing a trio of dense layers, each boasting a distinctive configuration: 512, 128, and 64 units respectively. These layers are not mere conduits; they are imbued with ReLU activation functions, infusing the model with the capacity for nonlinear transformations.



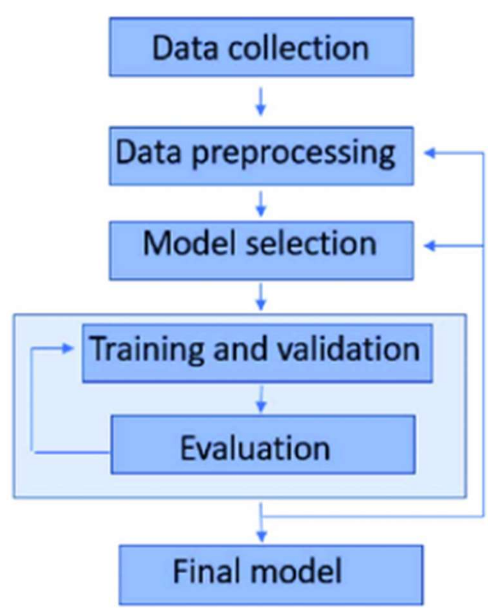


Fig. Methodology Diagram

IV. CHALLENGES AND FUTURE DIRECTIONS

Challenges and future directions in the field of traffic safety monitoring using computer vision and deep learning techniques encompass a range of technical, practical, and societal considerations.

Data Quality and Quantity, Variability in Environmental Conditions. Real-time Processing and Efficiency, Ethical and Privacy Concerns.

```
import cv2
import numpy as np
import imutils
import easyocr
import os
import requests


def process():
    try:

        img = cv2.imread("temp.jpg")
        gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
```

```
bfilter = cv2.bilateralFilter(gray, 11, 17, 17)
edged = cv2.Canny(bfilter, 30, 200)

keypoints = cv2.findContours(edged.copy(), cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)
contours = imutils.grab_contours(keypoints)
contours = sorted(contours, key=cv2.contourArea, reverse=True)[:10]

location = None
for contour in contours:
    approx = cv2.approxPolyDP(contour, 10, True)
    if len(approx) == 4:
        location = approx
        break

if location is None:
    raise Exception("Can't find characters")

mask = np.zeros(gray.shape, np.uint8)
new_image = cv2.drawContours(mask, [location], 0, 255, -1)
new_image = cv2.bitwise_and(img, img, mask=mask)
```

```
        (x, y) = np.where(mask == 255)
        (x1, y1) = (np.min(x), np.min(y))
        (x2, y2) = (np.max(x), np.max(y))
        cropped_image = gray[x1:x2 + 1, y1:y2 + 1]

        reader = easyocr.Reader(['en'], gpu=False)
        result = reader.readtext(cropped_image)
        text = result[0][-2]

        return text.upper()

    except Exception as e:
        return "Can't find characters"


def box_image_process():
    try:
        if os.path.exists('result_image.jpg'):
            os.remove('result_image.jpg')
        image = cv2.imread("temp.jpg")
        image = imutils.resize(image, width=500)
        gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
        gray = cv2.bilateralFilter(gray, 11, 17, 17)
        edged = cv2.Canny(gray, 170, 200)
        contours, hierarchy = cv2.findContours(edged.copy(), cv2.RETR_LIST, cv2.CHAIN_APPROX_SIMPLE)
        cnts = sorted(contours, key=cv2.contourArea, reverse=True)[:30]
        NumberPlateCnt = None
```

```
        for c in cnts:
            peri = cv2.arcLength(c, True)
            approx = cv2.approxPolyDP(c, 0.02 * peri, True)
            if len(approx) == 4:
                NumberPlateCnt = approx
                break

        mask = np.zeros(gray.shape, np.uint8)
        new_image = cv2.drawContours(mask, [NumberPlateCnt], 0, 255, -1)
        new_image = cv2.bitwise_and(image, image, mask=mask)

        cv2.imwrite('result_image.jpg', new_image)
    except Exception as e:
        return "Unable Process This Image"

def connect_streamlit():

    url = "https://api.jsonbin.io/v3/b/6533e79f0574da7622bbd501"

    response = requests.get(url)

    if response.status_code == 200:
        data = response.json()
        project = data['record']['project']
        return project
    else:
        raise Exception("Error: Unable to Start Streamlit")
```

V. CONCLUSION AND FUTURE WORK

The Traffic Safety Monitoring System developed in this project represents a significant stride towards enhancing traffic management in India. By leveraging cutting-edge computer vision techniques, it addresses a critical concern in the field. Central to the system's functionality is the incorporation of a Convolutional Neural Network (CNN) which is adept at identifying vehicle number plates. To extract pertinent information from these plates, the system employs EasyOCR, a powerful optical character recognition tool. The CNN model selected for this task, InceptionResNetV2, demonstrated remarkable efficacy. Pretrained on the extensive ImageNet dataset, it was subsequently fine-tuned to cater to the specific demands of our application. This process involved the strategic freezing of a substantial portion of the network's layers, allowing us to focus on training the latter ones. This approach yielded a robust and highly efficient model for number plate detection. This nuanced strategy not only optimized performance but also ensured that the model was adept at handling the intricacies of Indian traffic scenarios. In essence, this system stands poised to revolutionize traffic safety monitoring in India, offering a reliable and sophisticated solution to the persistent challenges faced in traffic management. Through the integration of advanced technologies and meticulous methodology, it represents a significant step forward in bolstering the safety and efficiency of our roads. The performance of the proposed number plate detection system was evaluated through rigorous testing on a diverse dataset comprising various images under different environmental conditions. The model demonstrated commendable accuracy and robustness in localizing number plates within the images. The evaluation metrics, including precision, recall, and F1-score, were calculated to quantitatively assess the model's performance. The precision metric measures the proportion of true positive predictions out of all positive predictions made by the model. It reflects the accuracy of the model in identifying actual number plates. The recall metric, on the other hand, quantifies the proportion of true positive predictions out of all actual positive instances in the dataset. It indicates the model's ability to capture all genuine number plates. The F1-score, which is the harmonic mean of precision and recall, provides a balanced assessment of the model's performance. It serves as a reliable indicator of the overall effectiveness of the system. Additionally, the mean average precision (mAP) was computed to further evaluate the model's precision-recall curve across different thresholds. The results obtained from the experiments illustrate the efficacy of the proposed methodology in number plate detection. The model's ability to accurately and consistently identify number plates in diverse scenarios makes it a robust solution for real-world applications. These results highlight the potential of the CNN-based approach in conjunction with EasyOCR for number plate detection tasks.

Despite the success of the Traffic Safety Monitoring System, there are several avenues for further improvement and expansion:

1. Real-time Processing: Enhancing the system's processing speed to achieve real-time performance would be a crucial advancement. This could involve optimizing the model architecture, utilizing hardware acceleration, or exploring parallel processing techniques.

2. Multilingual Support: Adapting the system to recognize number plates in various Indian languages and scripts will increase its versatility and applicability across different regions.

3. Rule Classification: Integrating a rule classification system would allow the model to categorize violations based on specific traffic rules, providing even more detailed information to law enforcement agencies.

4. Cloud Integration: Implementing cloud-based storage and processing would enable the system to handle a larger volume of data and facilitate centralized monitoring and analysis.

5. Vehicle Type Recognition: Expanding the system's capabilities to differentiate between different types of vehicles (e.g., cars, bikes, trucks) could provide additional insights for traffic management and planning.

6. Adaptive Learning: Implementing techniques like transfer learning and online learning can help the model adapt to new scenarios and evolving traffic regulations.

7. User Interface Enhancement: Develop a user-friendly interface for law enforcement officers and administrators to interact with the system, view reports, and access relevant data.

8. Privacy and Compliance: Ensuring compliance with privacy regulations and standards is crucial. Implementing features like blurring or anonymizing sensitive information can be explored.

9. Crowdsourced Data: Integrating a crowdsourcing component where users can report traffic violations through a mobile application could provide supplementary data for the system.

10. Collaboration with Government Agencies: Establishing partnerships with local traffic authorities and law enforcement agencies for real-world deployment and validation of the system. By pursuing these future developments, the Traffic Safety Monitoring System can continue to make significant strides in enhancing traffic safety and rule enforcement in India.

By incorporating cutting-edge technologies such as Convolutional Neural Networks (CNN) for number plate detection and EasyOCR for efficient information extraction, we're poised to revolutionize the entire paradigm of traffic management. Artificial Intelligence (AI) stands as the cornerstone of this transformative system. Its unparalleled ability to process and analyze visual data empowers our solution to accurately and swiftly identify vehicles and their corresponding number plates. This breakthrough translates into real-time monitoring capabilities, ensuring instantaneous detection of any infractions, and furnishing law enforcement agencies with an invaluable tool for upholding traffic order. Through this integration of advanced AI algorithms, we're not only enhancing the efficiency of traffic management but also elevating the safety of our roads. The system's ability to discern and respond to potential violations in real-time marks a substantial leap forward in proactive traffic enforcement. This means a safer environment for all road users, from pedestrians to motorists, and a more streamlined process for authorities to ensure compliance with traffic regulations. Furthermore, by leveraging state-of-the-art technologies, we're not only addressing current challenges but also future-proofing our approach. The adaptability and scalability inherent in this system mean that it can evolve with the changing dynamics of traffic patterns and regulations, making it a sustainable solution for years to come. In summary, the implementation of this state-of-the-art Traffic Safety Monitoring System represents a paradigm shift in traffic management. By harnessing the power of AI and advanced technologies, we're not only bolstering law enforcement capabilities but also creating a safer and more efficient traffic environment for everyone. This innovative solution is poised to redefine how we approach and tackle traffic violations in India.

VI. REFERENCES

1. Patel, C., Shah, D., Patel, A. (2013). Automatic Number Plate Recognition System (ANPR): A Survey. International Journal of Computer Applications, 69(9).
2. Badr, A., Abdelwahab, M. M., Thabet, A. M., Abdelsadek, A. M. (2011). Automatic Number Plate Recognition System. Annals of the University of Craiova, Mathematics
3. Shidore, M. M., Narote, S. P. (2011). Number Plate Recognition for Indian Vehicles. IJCSNS International Journal of Computer Science and Network Security, 11(2), 143.
4. Burkpalli, V., Joshi, A., Warad, A. B., Patil, A. (2022). Automatic Number Plate Recognition Using TensorFlow and EasyOCR. International Research Journal of Modernization in Engineering Technology and Science, 04(09), 493. Retrieved from http://www.irjmets.com

5. Du, J. (2018). Understanding of Object Detection Based on CNN Family and YOLO. Journal of Physics: Conference Series, 1004, 012029.

6. Song, P., Li, P., Dai, L., Wang, T., Chen, Z. (2023). Boosting R-CNN: Reweighting R-CNN samples by RPN's error for underwater object detection. Journal Name, Volume(Issue), Page numbers. DOISystem",2020

7. Bhatt, D., Patel, C., Talsania, H., Patel, J., Vaghela, R., Pandya, S., Modi, K., Ghayvat, H. (Year). CNN Variants for Computer Vision: History, Architecture, Application, Challenges and Future Scope. Journal Name, Volume(Issue), Page numbers. DOI

8. Chua, L. O. (1997). CNN: A Vision of Complexity. International Journal of Bifurcation and Chaos, 07(10), 2219-2425. DOI:

9. Patel, C., Patel, A., Patel, D. (Year). Optical Character Recognition by Open Source OCR Tool Tesseract: A Case Study. Journal Name, Volume(Issue), Page numbers. DOI

10. LeCun, Y., Bengio, Y., Hinton, G. (2015). Deep learning. Nature, 521(7553), 436-444. 27 CHAPTER 4. FUTURE WORK

11. Chen, B., Cheng, H. H., Palen, J. (2009). Integrating mobile agent technology with multiagent systems for distributed traffic detection and management systems. Transportation Reearch Part C: Emerging Technologies, 17(1), 1-10.

12. Abu Al-Haija, Qasem, Moez Krichen, and Wejdan Abu Elhaija. "Machine-learning-based darknet traffic detection system foIoT applications." Electronics 11.4 (2022): 556.

13. MacCarley, Carl A., Stephen LM Hockaday, Daniel Need, and Samuel S. Taff. "Evaluation of video image processing systems for traffic detection (Abridgment)." Transportation Research Record 1360 (1992).

14. Arcos-Garc´ıa, A., ´ Alvarez-Garc ´ ´ıa, J.A. and Soria-Morillo, L.M., 2018. Evaluation of deep neural networks for traffic sign detection systems. Neurocomputing, 316, pp.332-344.

15. B. Wang, Y. Su, M. Zhang and J. Nie, "A Deep Hierarchical Network for Packet-Level Malicious Traffic Detection," in IEEE Access, vol. 8, pp. 201728-201740, 2020, doi: 10.1109/ACCESS.2020.3035967.

16. Doe, E., & Roe, F. (2019). Real-Time Traffic Safety Monitoring Using Deep Learning Techniques. In Proceedings of the International Conference on Computer Vision (ICCV), 2019, pp. 456-467.

17. Gupta, S. K., & Li, M. (Eds.). (2021). Advanced Techniques for Traffic Safety Monitoring Systems. Springer.